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Comparison of weight estimation methods and evaluation of usability of Broselow Luten tape in Turkish children

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SUMMARY: Gültekingil-Keser A, Tekşam Ö. Comparison of weight estimation methods and evaluation of usability of Broselow Luten tape in Turkish children. Turk J Pediatr 2017; 59: 150-154.

It is controversial which method is more reliable for weight estimation of a child in an emergent situation. The aim of this study is to compare different methods and to review the applicability of Broselow Luten tape for Turkish children. This study was performed prospectively in patients presenting to pediatric emergency department. Weight estimation of patients were performed by parent, physician, nurse and Broselow Luten tape. Finally actual weight and height of the patient were measured. A total of 438 patients were eligible for the study. All estimates have a reliable correlation with actual weight. However, parent estimation is better followed by Broselow Luten tape. Correlation decreases as the weight of the child increases. When emergent care of an acutely ill child is necessary, parental estimation of the weight can be used. If it is unattainable, Broselow Luten tape can be reliably used instead of other methods especially in patients with lower weight.

Key words: Broselow Luten tape, children, pediatric emergency, weight estimation.

Pediatric emergency physicians tend to exactly know the weight of the patients when dealing with an emergent situation in order to assess and treat the patient properly. However actually weighing the patient might delay the urgent treatment, therefore many different weight estimation methods were studied[1-4]. It is important to use the method which is both quick and precise in order to use correct medication dose and correct equipment without wasting time[5].

Broselow Luten pediatric emergency tape uses length in order to estimate weight. It has color coded zones that provide doses of drugs, intravenous fluid volumes and size of equipment calculated for the estimated weight[2,6]. Ease of use and relatively high accuracy of estimation made Broselow Luten tape widely used and even supported by AHA guidelines[1,7,8]. However, debate still continues about its validity in different age groups, different weight groups and different populations in different countries[9-13].

The aim of this study is to compare different weight estimation methods including Broselow Luten pediatric emergency tape, and estimations of parents, physician and triage nurse with the actual weight of the child to understand which method is more reliable and to figure the applicability of Broselow Luten tape in Turkish children.

Material and Methods

The study is prospectively conducted in Hacettepe University Children's Hospital Pediatric Emergency Unit between January 1st 2013 and July 1st 2013. All patients presented to pediatric emergency department between 10:00 am and 12:00 pm were included in the study. Age, gender and medical condition of the patient were recorded. Weight of the patient was estimated by physician at triage (without using any formula), triage nurse and parent of the patient blindedly. Afterwards length of the patient was measured with Broselow Luten tape on supine position on examination bed and weight equivalent of the length is noted. Finally, actual length in cm and weight in kg

were measured and recorded. Weight and height were measured on upright position if patient can stand on his own, if not measurements were done in supine position. For immobile patients, parents hold the patient on measurement, then weight of the parent was subtracted from the measured weight. Weight percentiles for age were calculated for each patient and noted.

As Broselow Luten tape is 146 cm and it is designed for children up to 12 years old and 36 kg, the patients older than 12 years old, taller than 146 cm or heavier than 36 kg were excluded from the study. Patients with weight percentiles less than 3rd percentile or more than 97th percentile were excluded in order to analyze its appropriateness for children with average weight and height. Repeated recordings of the same patients were excluded. Our research was approved by the ethics commmitte of the university and written or verbal consent was obtained from the parents of all participants.

Statistical analysis was performed using SPSS 15.0. Cronbach's alfa coefficient for reliability, intraclass correlation coefficient (ICC) and 95% coefficient interval (CI) was used to measure overall difference between actual weight and parental, physician, nurse and Broselow Luten estimate and difference in each weight category. Bland-Altman plot was used to analyze agreement in each estimate category with actual weight.

Results

A total of 650 patients were enrolled in the study; 152 patients were excluded because they were older than 12 years. Five patients were excluded because they were taller than 146 cm and 13 patients were excluded because they were heavier than 36 kilograms. Fourty-two patients were excluded because weight of these patients were either less than 3rd percentile or more than 97th percentile for their age. Remaining 438 patients were included in the final analysis. Mean age of the patients was 4.27 years (1 month-12 years). One hundred ninty of the patients were girls (43.4%) and 208 were boys (56.6%). Mean weight of the patients was 16.98±8.81 kg, mean height of the patients was 99.29±26.67 cm.

All estimation methods have a reliable correlation with actual weight of the patient. Among different estimation methods, parental estimation had the highest correlation with actual estimation (ICC: 0.99; 95% CI: 0.98-0.99) followed by Broselow Luten tape (ICC: 0.97; 95% CI: 0.96-0.97). Nurse estimation was worse than parental estimation and Broselow Luten tape (ICC:0.96; 95% CI: 0.95-0.96). Physician estimation was the worst of all four estimates (ICC: 0.94; 95% CI: 0.93-0.95).

Bland-Altman plots show that Broselow Luten tape estimations tends to underestimate children especially when weight of children increases (Fig. 1). On the contrary estimations of nurses tend to overestimate when weight of children increases (Fig. 2). Physician estimations perform better in lower weight ranges but they tend to both over and underestimate when weight of children increases (Fig. 3). Parental estimates also perform better in low weight and its performance decreases as the weight increase however not as much as other estimates (Fig. 4).

When patients were classified according to weight percentiles, all estimates are reliable in each percentile group. Parental estimation had the highest correlation followed by Broselow Luten tape and physician estimation had the lowest correlation within each percentile group.

When patients were classified according to weight, all estimation methods perform better if patients weigh less than 10 kg. Reliability decreases as patients' weight increases except for parental estimation which performed better in >20 kg group than 10-20 kg group.

Discussion

Accurate and rapid weight estimation of a critically ill child in a pediatric emergency department is essential to prevent delay of treatment and dosing errors[5,14]. However it is difficult to decide the reliable method for weight estimation, some methods could give accurate results but they could be time consuming to calculate in an emergent situation[1,13,15]. Other methods may be subject to error they can be easily effected by assessment of different individuals[10].

Broselow Luten emergency tape is uncomplicated, easy to use, objective method for estimation of weight of children and provides the calculated doses of different medications and equipment which is very efficaceous in

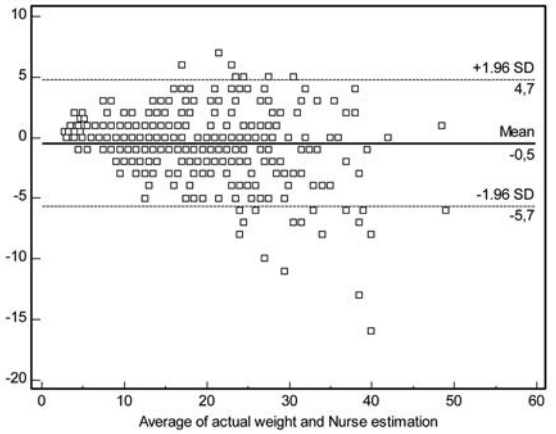

Fig. 2. Bland-Altman analysis of nurse estimate and actual weight

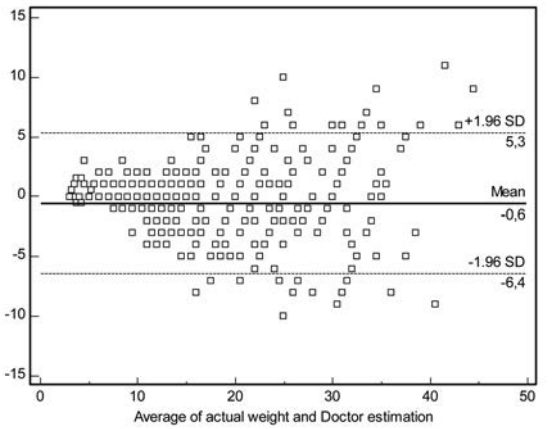

Fig. 3. Bland Altman analysis of physician estimate and actual weight

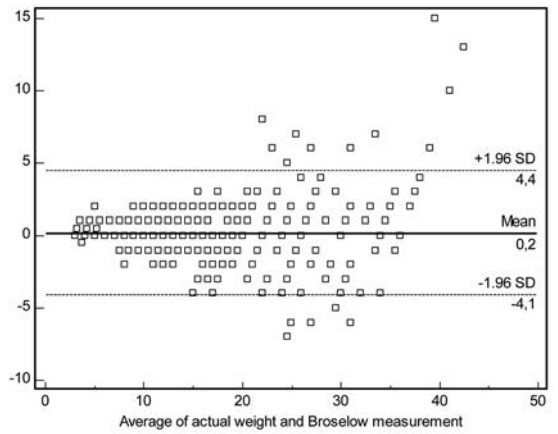

Fig 1. Bland Altman analysis of Broselow Tape

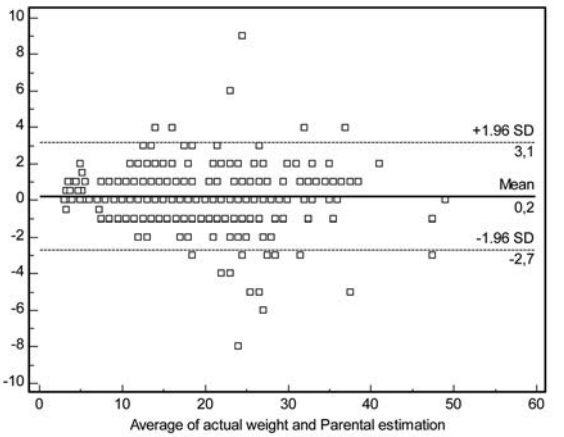

Fig. 4. Bland-Altman analysis of parental estimate and actual weight

an emergent situation[16,17]. However there are still questions about accuracy of the tape[9,11]. Nieman et al.[9] found that accuracy of the tape decreases with increasing age. Knight et al.[11] noted that half of the children fell outside the predicted weight range and emphasized that Broselow Luten tape underestimates the weight of children. Sinha et al.[18] reported that trauma stretcher integrated weighting scale gave better results than Broselow Luten tape. Age based formulas give comparable results with Broselow Luten tape[19,20].

Reliability of Broselow Luten tape differs betweeen different populations and its accuracy has never been evaluated in Turkish children[12,13,21-24]. Our results showed that Broselow Luten emergency tape can be reliably used in Turkish children with average weight and height. When it was compared with other estimations, parental estimation performed better than Broselow Luten tape in all weight categories. Krieser et al.[25] also previosuly reported that parental estimation of the weight was more accurate than Broselow Luten tape. However, Broselow Luten tape performed better than physician and nurse estimates in all weight categories, consistent with the study of Rosenberg et al.[8] in which physician estimations was worse than Broselow Luten tape except in obese patients, yet obese patients were not included in our study group.

When weight categories were considered, there was no significant difference in reliability of Broselow Luten tape in different weight percentiles for age. In contrast, reliability declines when weight of the patient increases in concordance with other studies[1,9,23,26]. However reliability of other estimation methods decreases as weight of the patient increases as well it does not bring an additional disadvantage

for Broselow Luten tape.

There are also other methods for accurate weight estimation that can be used in the emergency department. Age based methods or midarm circumference methods can result in fairly good estimation of weight especially in specific subgroups, even out performing Broselow Luten tape, however they could be time consuming in emergent situations[26,27]. There are newer tapes such as MERCY tape and PAWPER tape that were shown to be superior to Broselow Luten tape in weight estimation in few studies in literature. Therefore, future studies could be done to compare them with Broselow Luten tape for the Turkish population as well[28,29].

Limitations of our study were that we excluded the underweight and overweight children in order to show the applicability of Broselow Luten tape on average Turkish children. However, this study would be planned on patients with underweight and overweight children. Also, we only compared Broselow Luten tape with parental and medical staff estimations but Broselow Luten tape could be compared with other estimation methods and age based formulas as well. In addition to that, results would be more reliable if more than one nurse and physician estimation could have been used and interrater reliability was also assessed, however it would be time consuming for patients at triage. Therefore, we did not have chance to perform this assessment.

This is the first prospective study to investigate the usability of Broselow Luten tape in Turkish children. Parental estimation is the best of all estimation methods; Broselow Luten tape is the second best therefore Broselow Luten tape can be used for weight estimation if parental estimation is unattainable. Broselow Luten tape can be reliably used on Turkish children in an emergency medical situation.

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